GMRS, FRS, MURS FCC Rules & Equipment

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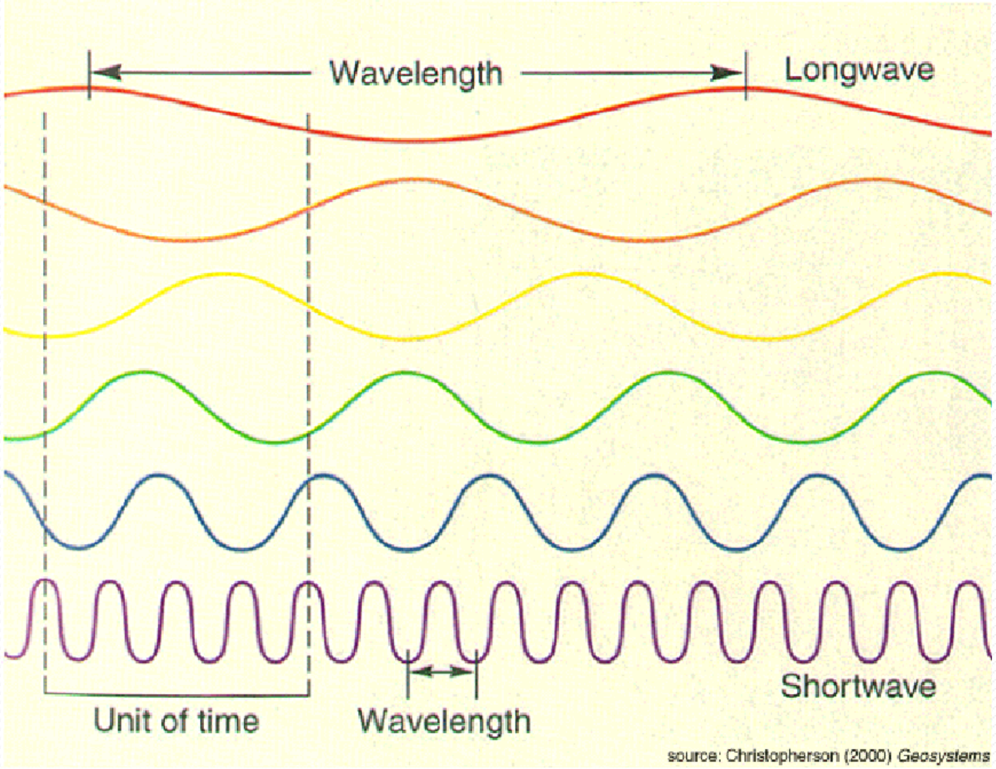
Some Basic Radio Fundamentals

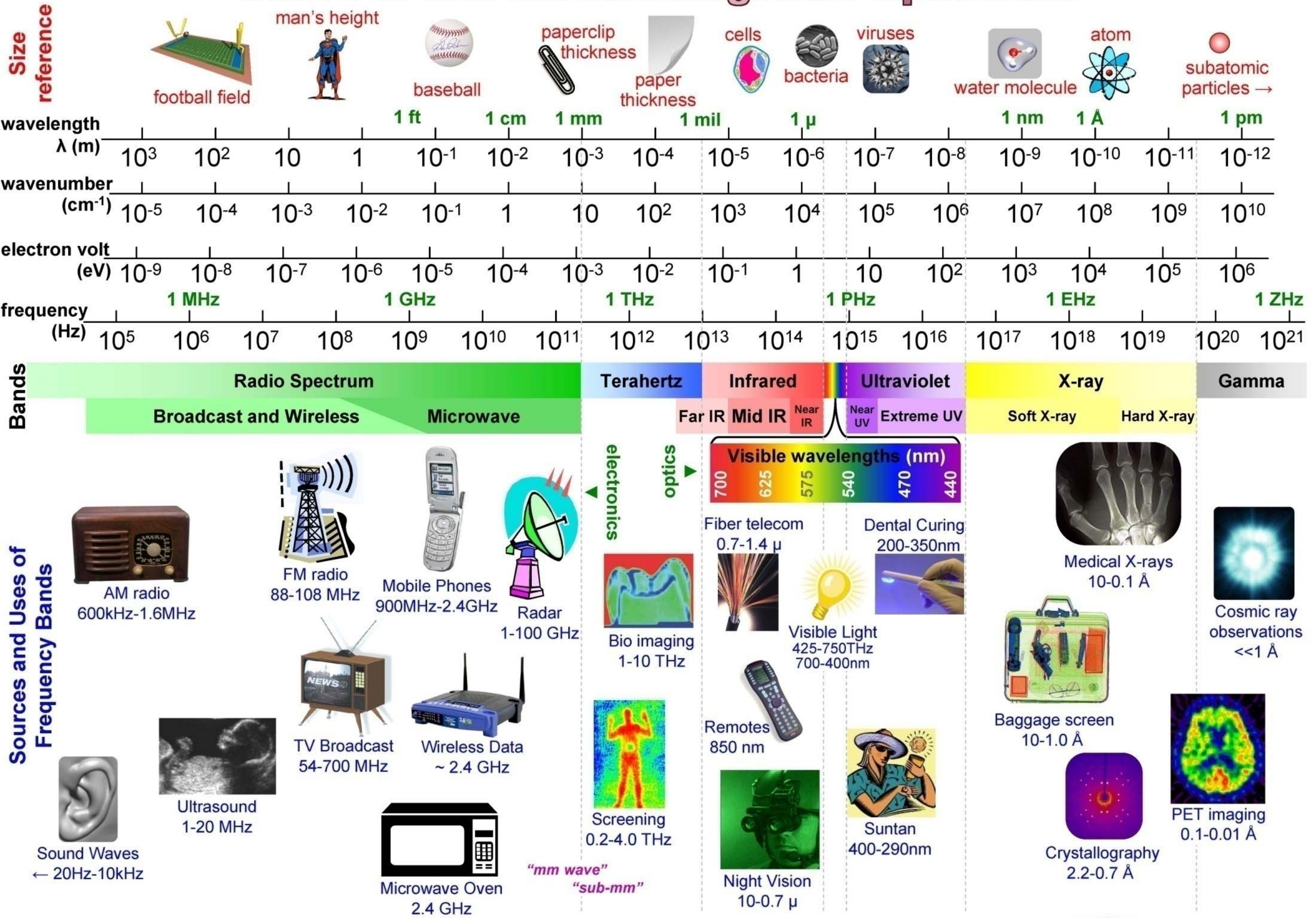
Wavelength & Frequency

- Wavelength gets shorter as the frequency increases
- Wavelength in meters equals 300 divided by frequency in megahertz
- A radio wave travels through space at the speed of light



source: Christopherson (2000) *Geosystems*

Chart of the Electromagnetic Spectrum



Size reference

football field, man's height, baseball, paperclip thickness, paper thickness, cells, bacteria, viruses, water molecule, atom, subatomic particles →

wavelength λ (m): 10^{3}, 10^{2}, 10, 1, 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9}, 10^{-10}, 10^{-11}, 10^{-12}

1 ft, 1 cm, 1 mm, 1 mil, 1 μ, 1 nm, 1 Å, 1 pm

wavenumber (cm^{-1}): 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}, 10^{-1}, 1, 10, 10^{2}, 10^{3}, 10^{4}, 10^{5}, 10^{6}, 10^{7}, 10^{8}, 10^{9}, 10^{10}

electron volt (eV): 10^{-9}, 10^{-8}, 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}, 10^{-1}, 1, 10, 10^{2}, 10^{3}, 10^{4}, 10^{5}, 10^{6}

frequency (Hz): 10^{5}, 10^{6}, 10^{7}, 10^{8}, 10^{9}, 10^{10}, 10^{11}, 10^{12}, 10^{13}, 10^{14}, 10^{15}, 10^{16}, 10^{17}, 10^{18}, 10^{19}, 10^{20}, 10^{21}

1 MHz, 1 GHz, 1 THz, 1 PHz, 1 EHz, 1 ZHz

Bands

Radio Spectrum, Terahertz, Infrared, Ultraviolet, X-ray, Gamma

Broadcast and Wireless, Microwave, Far IR, Mid IR, Near IR, Near UV, Extreme UV, Soft X-ray, Hard X-ray

Visible wavelengths (nm): 700, 625, 575, 540, 470, 440

◀ electronics

optics ▶

Sources and Uses of Frequency Bands

Sound Waves
← 20Hz-10kHz

AM radio
600kHz-1.6MHz

Ultrasound
1-20 MHz

FM radio
88-108 MHz

TV Broadcast
54-700 MHz

Mobile Phones
900MHz-2.4GHz

Wireless Data
~ 2.4 GHz

Microwave Oven
2.4 GHz

Radar
1-100 GHz

"mm wave"

"sub-mm"

Bio imaging
1-10 THz

Screening
0.2-4.0 THz

Fiber telecom
0.7-1.4 μ

Remotes
850 nm

Night Vision
10-0.7 μ

Visible Light
425-750THz
700-400nm

Dental Curing
200-350nm

Suntan
400-290nm

Medical X-rays
10-0.1 Å

Baggage screen
10-1.0 Å

Crystallography
2.2-0.7 Å

Cosmic ray observations
<<1 Å

PET imaging
0.1-0.01 Å

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$\lambda = 3\times10^{8}/\text{freq} = 1/(\text{wn}*100) = 1.24\times10^{-6}/\text{eV}$

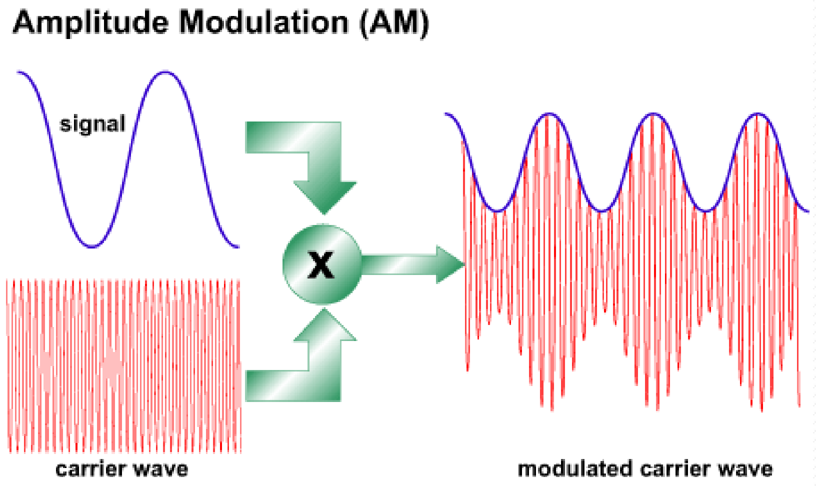
SURA Southeastern Universities Research Association ®

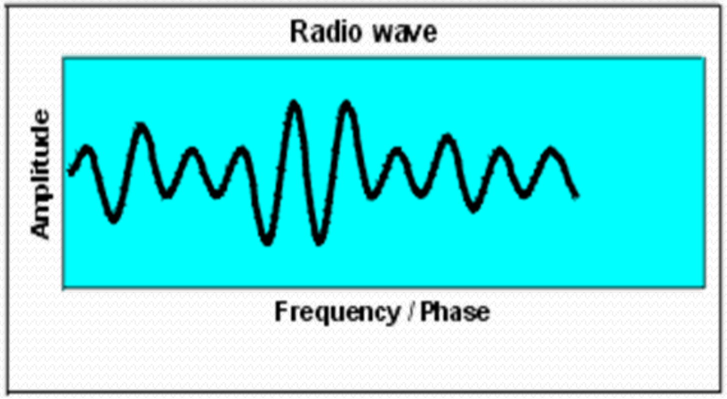
What is Radio Communications?

- A radio signal by itself does not carry any information
- Basic principle of radio communications is combining a radio wave with an ***information signal*** and transmitting it
- A receiver separates the ***information signal*** from the radio wave
- Combining an information signal with a radio signal is called “Modulation”
  - Modulation = adding information
  - Demodulation = recover the information

Amplitude Modulation

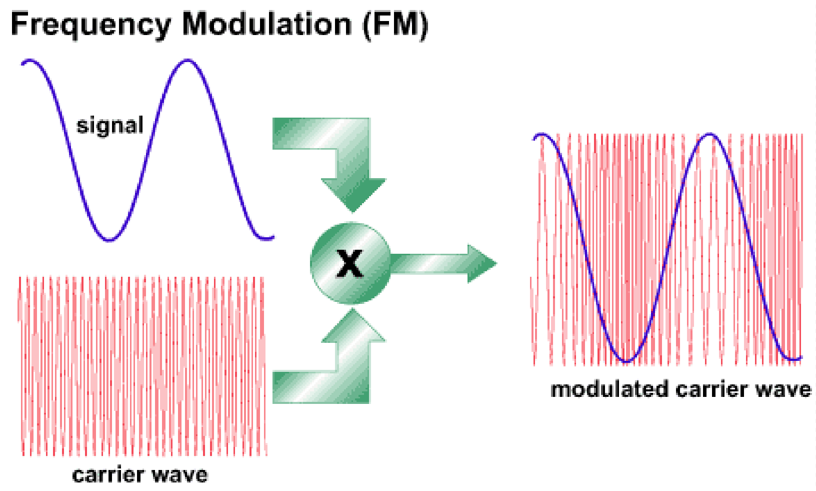
- AM = Amplitude Modulation
- AM is type of transmission that uses carrier wave to carry your voice
- Modulation is speech, Morse code, picture information, etc.
- When you talk through radio microphone you are modulating

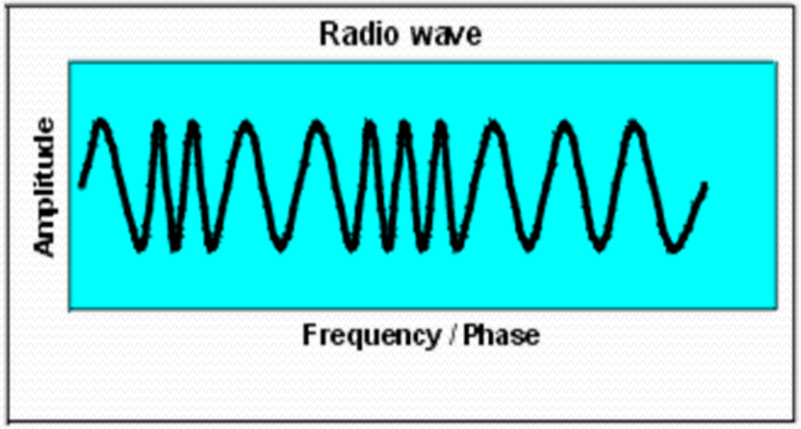




Frequency Modulation

- FM = Frequency Modulation
- FM is type of transmission that uses carrier wave but is slightly different
- Frequency is modulated
- Amplitude of the wave remains constant





Antenna Basics

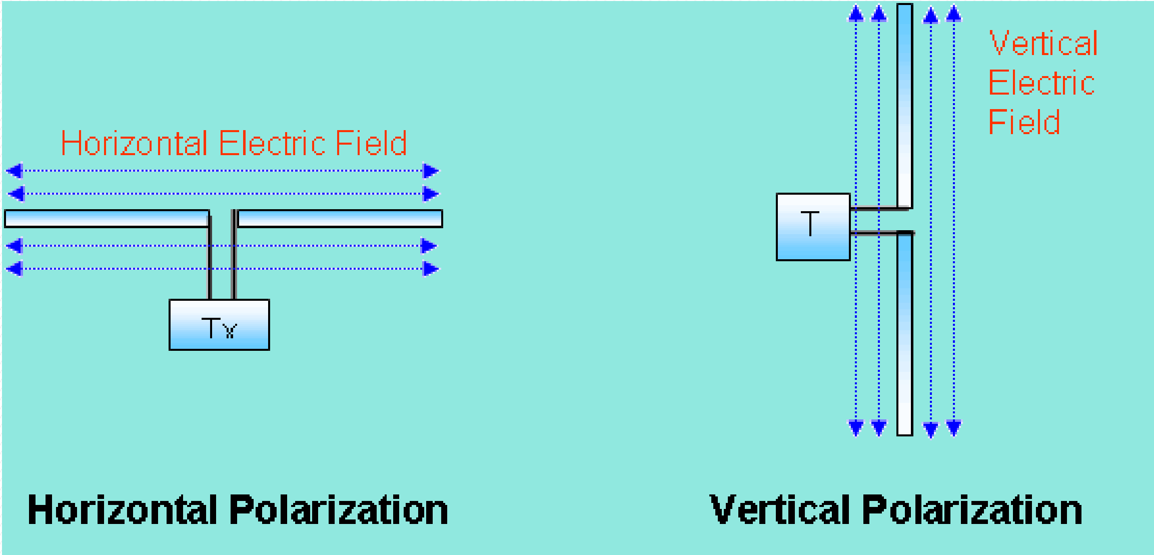
- Rule #1
  - Any conductor can act as an antenna for radio signals

Antenna Basics

- Rule #2
  - Any conductor may not radiate efficiently
  - For an antenna to radiate and receive radio signals efficiently
    - Dimensions must be an appreciable fraction of the signal's **wavelength**
- Rule #3
  - The most important point about UHF radios is that ANTENNA HEIGHT is more important than the output power of the device
  - A 4-watt handheld radio attached to an antenna on the roof of a vehicle can frequently communicate nearly as far as a 50-watt mobile transmitter connected to the same antenna
    - The more than 10 times additional power of the 50-watt unit rarely increases the communications range more than 20% or 30%.
- Antennas radiate (or receive) because electrons are moving (or are caused to move) back and forth in their elements
- Antennas transmit & receive radio waves in the same way

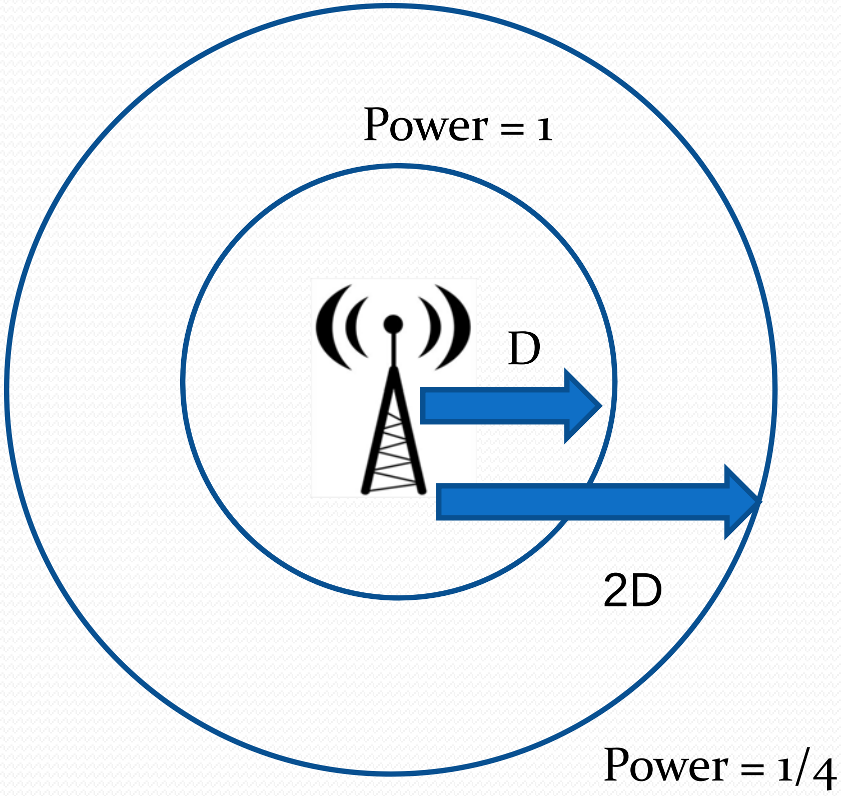
Polarization

- Direction in which the electric field radiating from the antenna is oriented
- You want transmitting and receiving antenna to be lined up the same way!



Propagation

- Term used to explain how radio waves behave when transmitted
- Radio waves obey inverse square law
  - E.g., power is inversely proportional to the square of the distance
  - Doubling distance from transmitter → power will be ¼ of previous value



How Radio Waves Travel

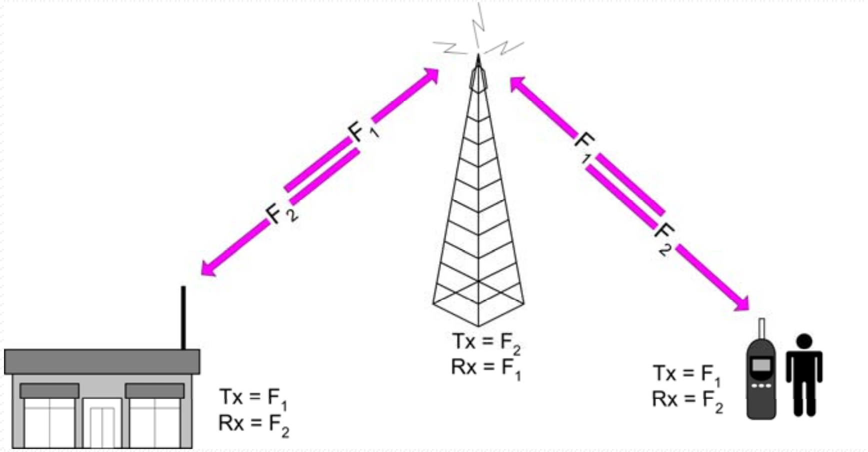
- VHF/UHF Propagation Characteristics
  - Line-of-sight Propagation
    - Directly from one point to another
  - Tropospheric Bending and Ducting
    - In the lower layer of the Earth's atmosphere
  - Sky-Wave
    - Refracted or bent back to the Earth's surface by ionized layers in ionosphere
  - Reflection
    - Buildings, water towers, mountains, jetliners, meteors
  - Atmosphere absorbs the radio waves at VHF/UHF
    - Higher the frequency, the more absorption by water (rain, fog)

Radio “Distortion”

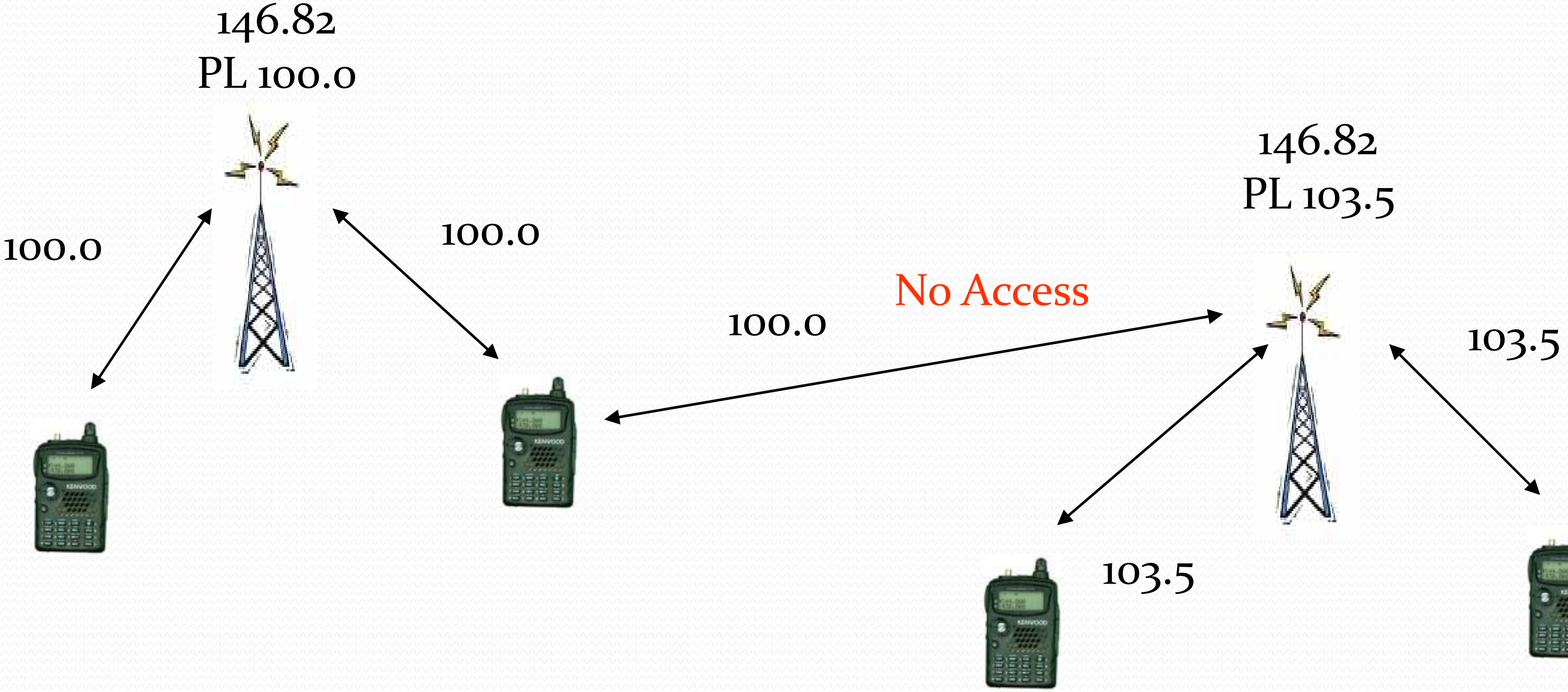
- Picket fencing
  - Term commonly used to describe the rapid fluttering sound sometimes heard from mobile stations that are moving while transmitting
- Multi-Path Distortion
  - If a station reports that your signals were strong just a moment ago, but now they are weak or distorted, random reflections may be causing multi-path distortion
- Try moving a few feet

Repeaters

- Extends usable range of mobile and low power stations
  - If a repeater with a tall antenna can hear a mobile signal 20 miles away (a typical distance for a well-sited repeater), then it can usually transmit to another mobile unit anywhere within that same 20-mile radius
- Repeaters are usually located at places of high elevation, enabling the repeater to "see" a long distance
- Disadvantage:
  - When one repeater is transmitting, it can block out or interfere with all other communications on that same frequency within that same area



CTCSS



146.82
PL 100.0

100.0

100.0

146.82
PL 103.5

No Access

100.0

103.5

103.5

Basic Terminology

- Family Radio Service (FRS)
- General Mobile Radio Service (GMRS)
- Combo or Hybrid Radios (FRS/GMRS)
- Multi-Use Radio Service (MURS)
- Amateur Radio (HAM)

- FCC rules
  - 47 Code of Federal Regulations (CFR) Part 95
  - 47 CFR Part 97 (Amateur Radio)

47 CFR Part 95 - Personal Radio Services

- Subpart A – General Mobile Radio Service (GMRS)
- Subpart B - Family Radio Service (FRS)
- Subpart C - Radio Control (R/C) Radio Service
- Subpart D - Citizens Band (CB) Radio Service
- Subpart F - 218 - 219 MHz Service
- Subpart G - Low Power Radio Service (LPRS)
- Subpart H - Wireless Medical Telemetry
- Communications Service (WMTS)
- Subpart I - Medical Implant Communications Service
- (MICS)
- Subpart J - Multi-Use Radio Service (MURS)

47 CFR Part 95

- Part 95 is unique in that some of it’s Subparts don’t require an station license
- These Subparts which require **equipment approval** but not an operator license are :
  - Family Radio Service
  - Radio Control Service
  - Citizens Band Service
  - Multiuse Radio Service

GMRS

- The General Mobile Radio Service (GMRS) is a licensed radio system, using handheld, mobile, or base stations
- Repeater systems are allowed on GMRS
- GMRS radios are typically handheld portable devices, and share some frequencies with FRS frequencies
- GMRS radios provide very good clarity over a slightly longer range than FRS
- Only those radios that have been type-certified by the FCC for use in the GMRS may be used
- GMRS requires an FCC license ($85/5 years)

GMRS Characteristics

- Uses “channelized” frequencies in the UHF band
  - Operate on any of 16 dedicated channels
  - Channels are used on a shared basis
  - Not assigned for the exclusive use of any licensee
  - All station operators and GMRS system licensees must cooperate in the selection and use of channels to reduce interference and to make the most effective use of the facilities
- Is quiet and clear because it uses frequency modulation (FM)
- Maximum power is 50 watts
  - Small control station north of line A → 5 watts ERP
  - Small base station → 5 watts ERP
  - Fixed station → 15 watts output power
- At the nearly "line of sight" frequencies of the GMRS, communications range is affected more by antenna height than by transmitter power
  - A 4-watt handheld radio attached to an antenna on the roof of a vehicle can frequently communicate nearly as far as a 50-watt mobile transmitter connected to the same antenna

GMRS

- Is intended for use by an individual who possesses a valid GMRS license, as well as his or her immediate family members
  - FCC definition of immediate family includes a spouse, children, parents, grandparents, aunts, uncles, nephews, nieces, and in in-laws
- Immediate relatives of the GMRS system licensee are entitled to communicate among themselves for personal or business purposes
- Employees or friends of the licensee, who are not family members, may not use your license
  - they must obtain their own
- There is no longer a GMRS license available for clubs or groups

Who can get a GMRS License?

- Individual
  - An individual (one man or one woman) is eligible to obtain, renew, and have modified a GMRS system license
  - If that individual is 18 years of age or older
  - Is not a representative of a foreign government
- Non-individual
  - A non-individual (an entity other than an individual) is ineligible to obtain a new GMRS system license or make a major modification to an existing GMRS system license
  - GMRS system licensed to a non-individual before July 31, 1987, is eligible to renew that license provided:
    - Partnership and each partner is 18 years of age or older; a corporation; an association; a state, territorial, or local government unit; or a legal entity

How do I get a license?

- Online through the FCC's Universal Licensing System (ULS)
  - http://wireless.fcc.gov/uls/index.htm?job=home
  - New users must register and receive an FCC Registration Number (FRN)

- Alternative → file FCC Form 605 manually
  - http://www.fcc.gov/Forms/Form605/605.html

What can I do with this license?

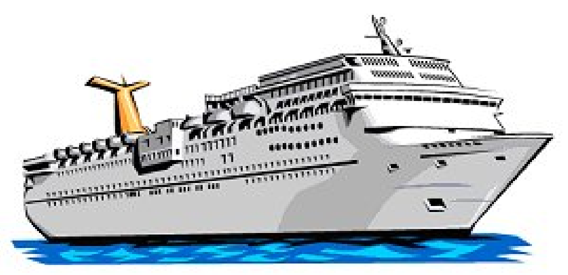
- Transmit messages to other GMRS stations at any geographical location within or over the territorial limits of any area where radio services are regulated by the FCC
  - Personal or business activities
  - Messages may include Emergencies; Rendering assistance to a motorist; and Civil defense drills, if the responsible agency requests assistance
- You cannot:
  - Operate as a common carrier or communication of messages for pay
  - Provide "phone patches" or "auto patches"
- As the licensee you are responsible for the proper operation of the GMRS system at all times
  - Also responsible for the appointment of a "station operator"

GMRS System

- Station operator(s)
- One mobile station consisting of one or more mobile units
- One or more land stations (optional)
- Paging receivers (optional)
- Fixed stations (optional)

GMRS Mobile Station

- One or more units that transmit while moving
  - Yes, you can make temporary stops at “unspecified points”
- You may transmit from a ship or aircraft with the captain’s permission
  - Including international waters if the ship is of U.S. registry



GMRS Land Station

- The old “fixed station” → Transmits from a specific address as determined by the licensee ***back when licenses were required to list location***
- Small Control Station
  - Has an antenna no more than 6.1 meters (20 feet) above the ground or above the building or tree on which it is mounted
  - Transmits with no more than 5 watts ERP (effective radiated power) *if north of Line A*
- Small Base Station
  - Has an antenna no more than 6.1 meters (20 feet) above the ground or above the building or tree on which it is mounted
  - Transmits with no more than 5 watts ERP
  - *Can operate on the shared FRS channels*

What is a “paging receiver”?

- A paging receiver is a unit capable of receiving the radio signals from a base station for the bearer to hear a page (someone’s name or other identifier said in order to find, summon or notify him/her) spoken by the base station operator

Frequencies & Repeaters

- A repeater station is a special kind of base station that receives signals on one frequency (in the 467 MHz band), and automatically (and usually, nearly simultaneously) retransmits that signal on another frequency (in the 462 MHz band 5 MHz below the transmit frequency)
  - Repeater Transmit Frequencies:
    - 467.5500, 467.5750, 467.6000, 467.6250, 467.6500, 467.6750, 467.7000 and 467.7250
  - Repeater Receive or Simplex Frequencies:
    - 462.5500, 462.5750, 462.6000, 462.6250, 462.6500, 462.6750, 462.7000 and 462.7250
- May here “channel designator” as 3 digits following decimal point:
  - E.g., for the 462.5500 and 467.5500 pair, the “designator” is “550”
- Base stations and repeater stations may transmit only on the 462 MHz frequencies
- Mobile stations may also transmit on these 462 MHz frequencies, for communicating directly with base stations or with other mobile units
- Mobile stations may also transmit on the upper (467 MHz band) frequencies to a repeater, which then retransmits the very same signal automatically on the paired 462 MHz band frequency exactly 5 MHz lower
- Licensee may limit the use of repeater to only certain user stations to only certain user stations
- A base station can also be set up as a repeater by receiving a signal in the 462 MHz band, and then retransmitting that same signal after a slight delay on the same frequency
- Nationwide emergency and road information calling frequency: 462.675 MHz
  - Emergency repeater operation use CTCSS of 141.3 Hz

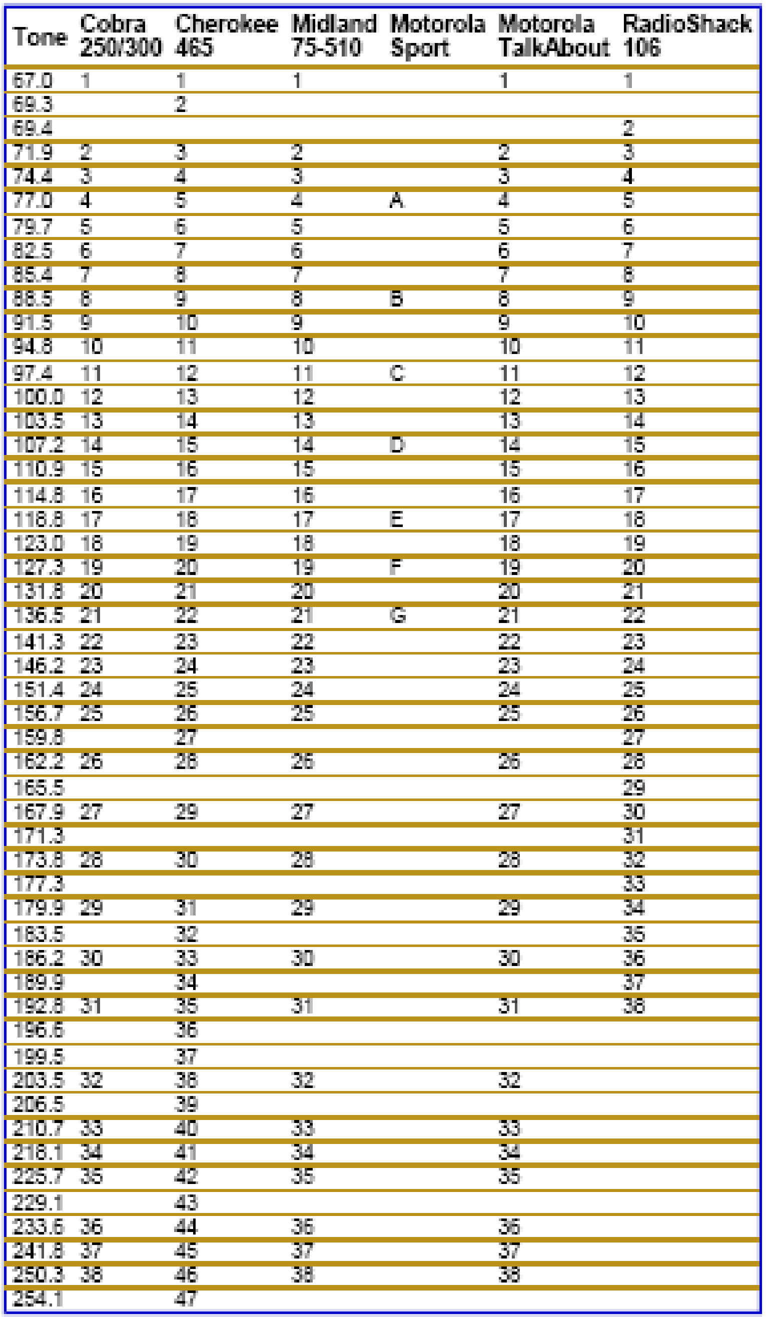
GMRS Repeaters in Washington

- BARN-R5 462.550 MHz Snohomish, WA Permission Required
- Wenatchee Heights 550 462.550 MHz Wenatchee, WA Permission Required
- **Capitol Hill HUB 462.550 MHz Seattle, WA Open System**
- Mazama 675 462.675 MHz Winthrop, WA Open System
- **MIQ HUB 462.625 MHz Seattle, WA Permission Required**
- SE Wenatchee Valley 575 462.575 MHz East Wenatchee, WA Permission Required
- **NE Seattle Hub Repeater 462.675 MHz Seattle, WA Open System**
- SW Wenatchee Valley 725 462.725 MHz Wenatchee, WA Permission Required
- **West Seattle HUB 462.550 MHz West Seattle, WA Permission Required**

Repeater Listings: www.myGMRS.com

CTCSS

- CTCSS, PL, or “Privacy codes” → nice feature to have because they effectively expand the number of channels you can use by adding 38 CTCSS (Continuous Tone Coded Squelch System) codes
- For example, in the case of FRS radios, instead of having just 14 channels from which to choose, with these sub-channels you are effectively provided with 14 x 38 CTCSS codes, or 532 available “channels”
- This makes it much easier to find a free frequency in crowded areas such as stadiums, amusement parks or shopping malls
- The term "privacy code" is a bit misleading
  - Choosing a given code does not block or scramble that channel or in any way prevent others from listening in
- If you want GMRS and FRS radios of differing brands to talk to each other, you'll need this info
- Note many FRS makers call these "privacy codes"



Tone	Cobra 250/300	Cherokee 465	Midland 75-510	Motorola Sport	Motorola TalkAbout	RadioShack 106
67.0	1	1	1		1	1
69.3		2				
69.4						2
71.9	2	3	2		2	3
74.4	3	4	3		3	4
77.0	4	5	4	A	4	5
79.7	5	6	5		5	6
82.5	6	7	6		6	7
85.4	7	8	7		7	8
88.5	8	9	8	B	8	9
91.5	9	10	9		9	10
94.8	10	11	10		10	11
97.4	11	12	11	C	11	12
100.0	12	13	12		12	13
103.5	13	14	13		13	14
107.2	14	15	14	D	14	15
110.9	15	16	15		15	16
114.8	16	17	16		16	17
118.8	17	18	17	E	17	18
123.0	18	19	18		18	19
127.3	19	20	19	F	19	20
131.8	20	21	20		20	21
136.5	21	22	21	G	21	22
141.3	22	23	22		22	23
146.2	23	24	23		23	24
151.4	24	25	24		24	25
156.7	25	26	25		25	26
159.8		27				27
162.2	26	28	26		26	28
165.5						29
167.9	27	29	27		27	30
171.3						31
173.8	28	30	28		28	32
177.3						33
179.9	29	31	29		29	34
183.5		32				35
186.2	30	33	30		30	36
189.9		34				37
192.8	31	35	31		31	38
196.6		36				
199.5		37				
203.5	32	38	32		32	
206.5		39				
210.7	33	40	33		33	
218.1	34	41	34		34	
225.7	35	42	35		35	
229.1		43				
233.6	36	44	36		36	
241.8	37	45	37		37	
250.3	38	46	38		38	
254.1		47				

Shared FRS Frequencies

- “Split” frequencies
  - 462.5625, 462.5875, 462.6125, 462.6375, 462.6625, 462.6785, 462.7125
- Only mobile units and "small base stations" may transmit on these frequencies
  - A "small base station" is a base station that has an antenna that extends not more than 20 feet above the ground or above the building or structure on which it is mounted
- GMRS transmissions on these "split" frequencies are limited to not more than 5 watts ERP (effective radiated power, which includes any antenna gain)
  - This applies both to mobile stations and to small base stations
- These frequencies may not be used by a repeater station (regardless of antenna height or transmitter power), nor by any base station with more than 5 watts ERP or with an antenna which extends more than 20 feet above the ground or above the structure on which that antenna is mounted
- Intended to be used only by handheld GMRS radios, or by comparable low-power mobile units

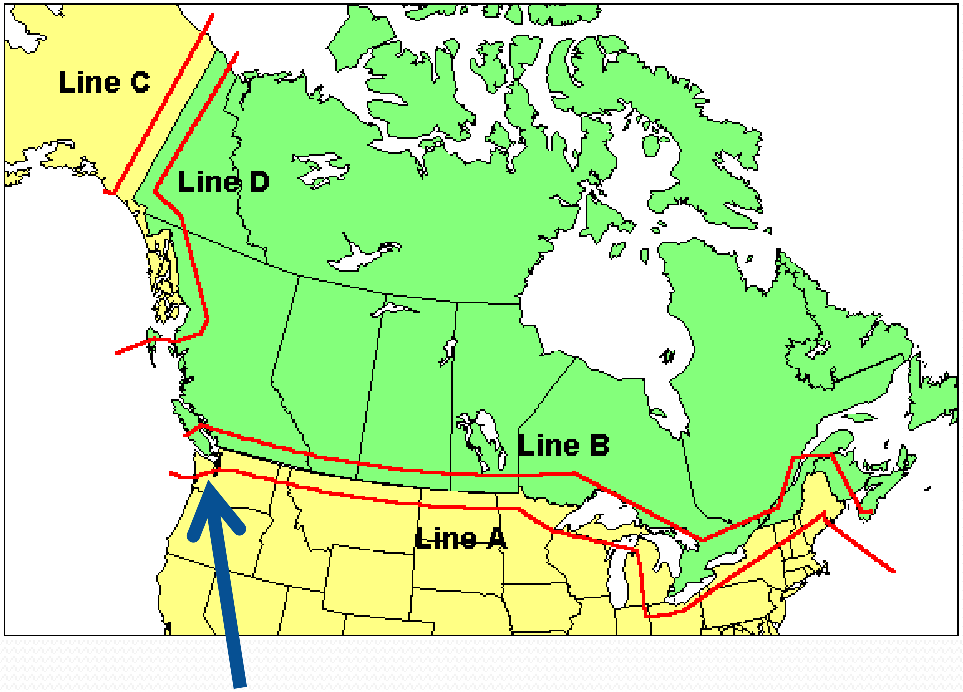
Interference

- Licensees of GMRS systems suffering or causing harmful interference are expected to cooperate and resolve this problem by mutually satisfactory arrangements
  - If not and the problem is raised to the FCC, the FCC may impose restrictions *on the stations concerned* including:
    - Specifying the transmitter power
    - Specifying the antenna height, or
    - Specifying the area or hours of operation

- The use of any frequency at a given geographical location may be denied when, in the judgment of the FCC, its use in that location is not in the public interest
  - The use of any channel or channel pair may be restricted as to specified geographical areas, maximum power, or other operating conditions

Line A

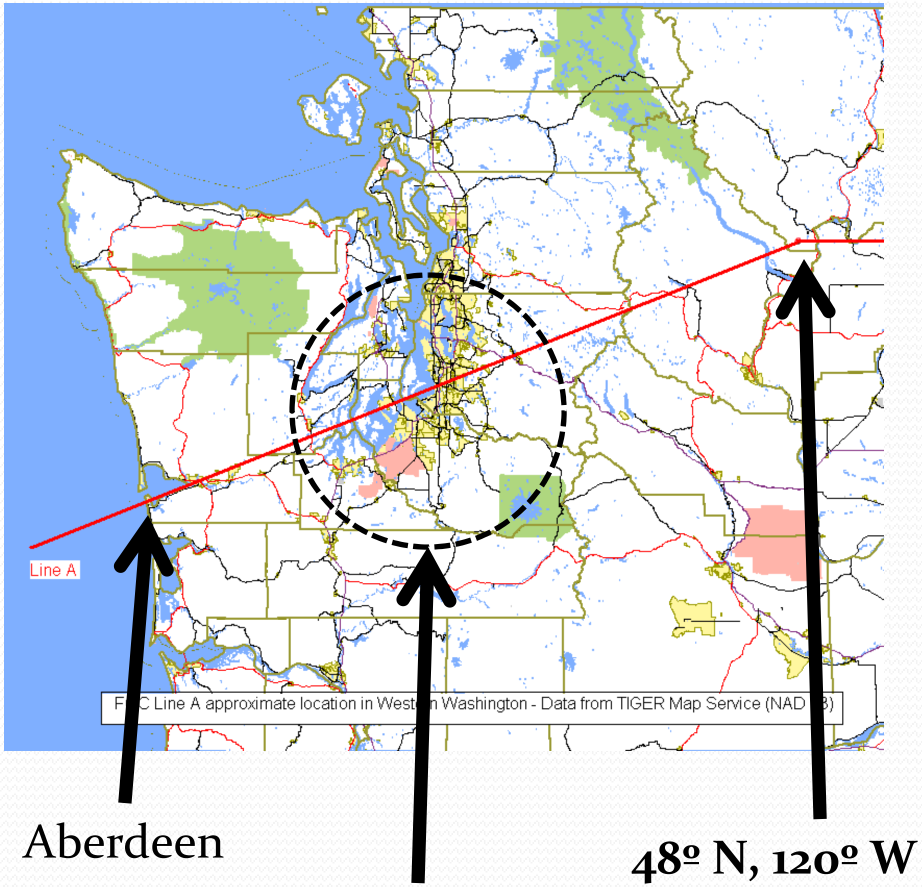
- In Canada, certain frequencies are used for services other than GMRS
- Treaty rules → use of frequencies 462.650, 467.650, 462.700 and 467.700 MHz is not permitted near the Canadian border North of Line A and East of Line C
- Small Control Station → limited to 5 watts north of line A



So where is Line A in Puget Sound???

Line A in Western Washington

- Line A. **Begins at Aberdeen, WA, running by great circle arc to the intersection of 48º N, 120º W, thence along parallel 48º N**, to the intersection of 95º W, thence by great circle arc through the southernmost point of Duluth, MN, thence by great circle arc to 45º N, 85º W, thence southward along meridian 85º W, to its intersection with parallel 41º N, thence along parallel 41º N, to its intersection with meridian 82º W, thence by great circle arc through the southernmost point of Bangor, ME, thence by great circle arc through the southernmost point of Searsport, ME, at which point it terminates.

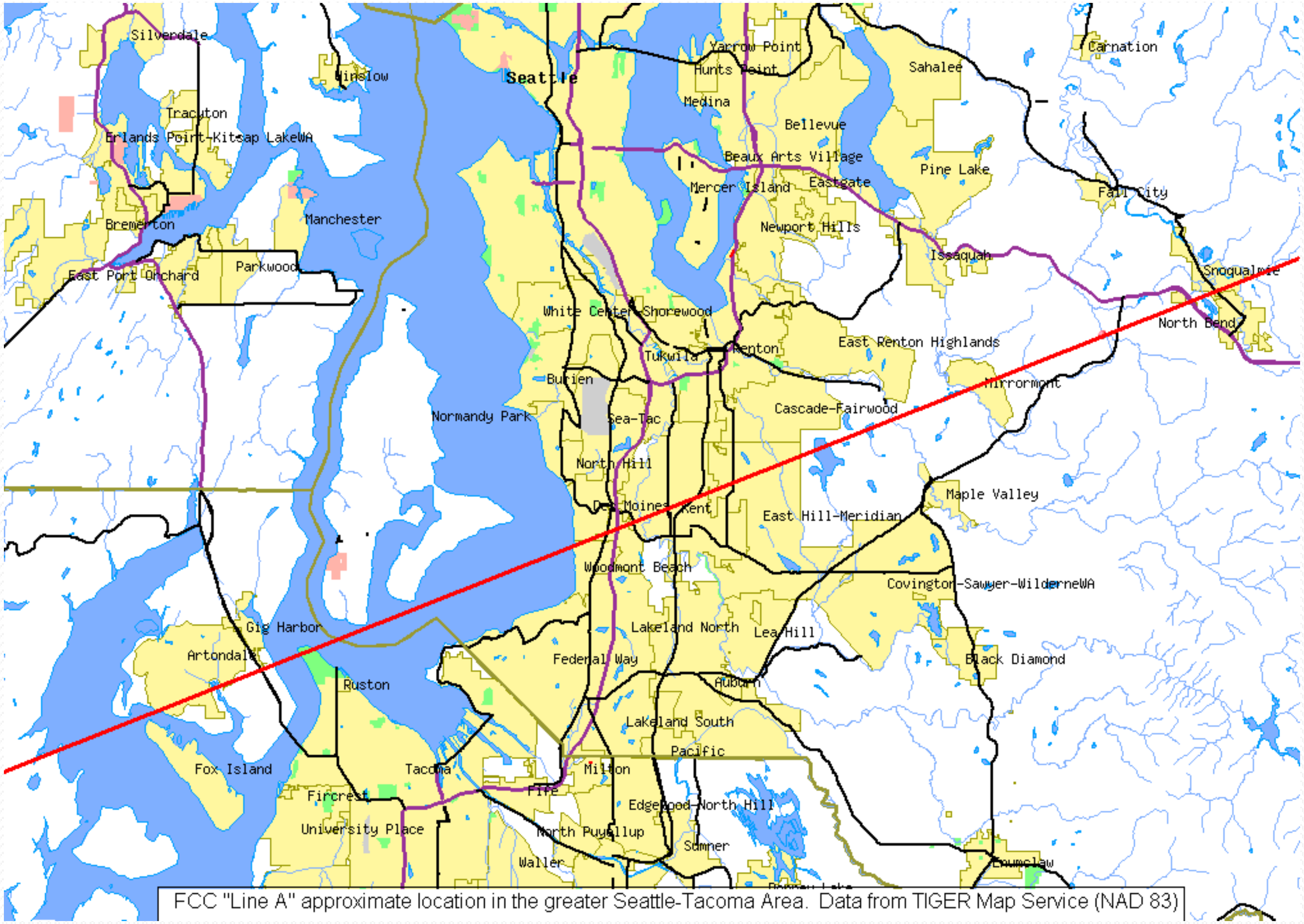

Line A
F C Line A approximate location in West n Washington - Data from TIGER Map Service (NAD 3)

Aberdeen

What about here?

48º N, 120º W

Line A in Seattle/Tacoma Area



FCC "Line A" approximate location in the greater Seattle-Tacoma Area. Data from TIGER Map Service (NAD 83)

What about our neighbors to the north?

- In Canada, hand-held GMRS radios up to 2 watts have been approved for use without a license since September 2004
- Typically these are dual FRS and GMRS units, with fixed antennas, and operating at 2 watts on some GMRS channels and 0.5 watts on the FRS-only channels
- Mobile units (permanently mounted in vehicles), base stations and repeaters are not currently permitted on the GMRS channels in Canada

Industry Canada RSS 210
Low-power Licence-exempt
Radiocommunication Devices
(All Frequency Bands):
Category I Equipment

GMRS Operating Procedures

- Transmissions must be in plain language (without codes or hidden meanings)
  - They may be in a foreign language, except for call signs
  - May communicate a one-way voice page to a paging receiver
- Every GMRS station must transmit the call sign assigned to the GMRS system or station:
  - Following the transmission of communications or a series of communications
  - Every 15 minutes during a long transmission
  - A unit number may be included after the call sign in the identification
  - Identification in voice or morse code (“CW”)
- When transmitting, you must have a station operator (licensee or immediate family) at the “control point” of the station
  - You can be a station operator for more than one station (e.g., repeater)
  - Controls the station
  - Must also cooperate in sharing each channel with station operators of other stations
- You must stop transmitting when any station on the same channel is communicating an *emergency message* (concerning the immediate protection of property or the safety of someone’s life)
  - You can let anyone be the station operator to communicate an emergency message

Prohibited Transmissions

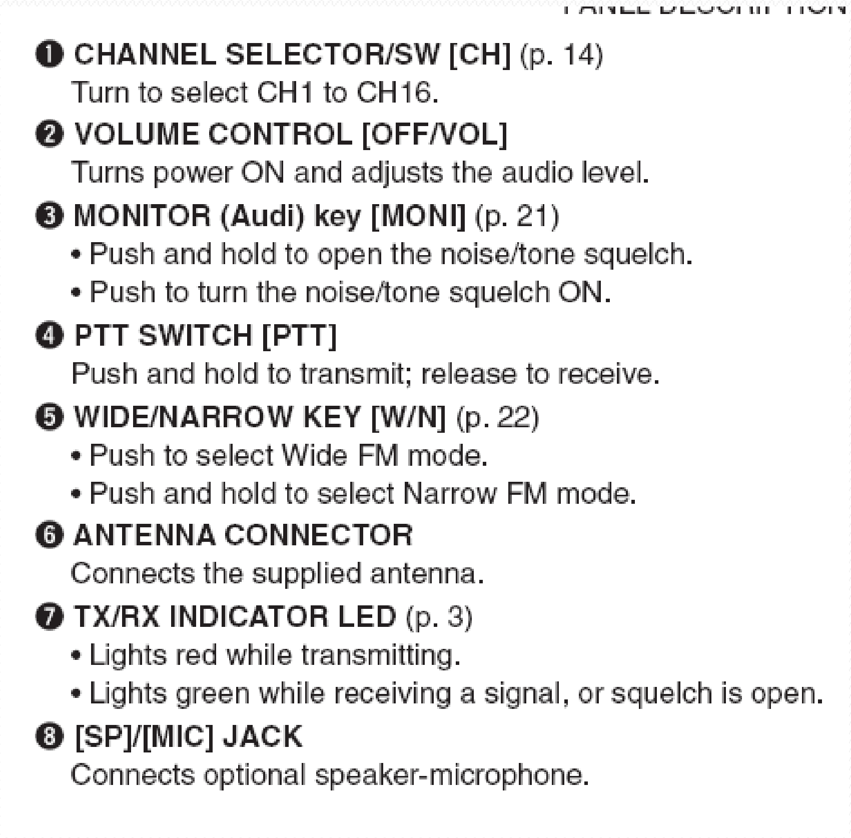
- Messages for hire, whether the remuneration received is direct or indirect
- Messages in connection with any activity which is against Federal, State, or local law
- False or deceptive messages
- Coded messages or messages with
- hidden meanings ("10 codes" are permissible)
- Intentional interference
- Music, whistling, sound effects or material to amuse or entertain
- Obscene, profane or indecent words, language or meaning;
- Advertisements or offers for the sale of goods or services
- Advertisements for a political candidate or political campaign (messages about the campaign business may be communicated)
- International distress signals, such as the word "Mayday" (except when on a ship, aircraft or other vehicle in immediate danger to ask for help)
- Programs (live or delayed) intended for radio or television station broadcast
- Messages which are both conveyed by a wireline control link and transmitted by a GMRS station
- Messages (except emergency messages) to any station in the Amateur Radio Service, to any unauthorized station, or to any foreign station
- Continuous or uninterrupted transmissions, except for communications involving the immediate safety of life or property
- (Messages for public address systems.

To D'oh or not to D'oh

GMRS Equipment & Accessories

- Handheld Radio
  - best mobility and flexibility of use
  - Mid $100s up to >$400
- Mobile, or vehicle-mounted radios
  - Supplement handheld radios
  - With a power supply, some vehicular radios can also be used as base stations
  - Mid $200s to >$300
  - Mobile antennas ~$50 and up
- Base Station
  - Can go as high as ~$400
  - Antennas ~$75-$350
- Headsets
  - From $20 to $200
- Speaker Microphones
  - ~$30-$50+
- Chargers
- 9V cable
- Belt Clips
- Cases
- Batteries ~$15 to >$100
  - Alkaline
  - Ni-Cd
  - Ni-MH
  - Li-ion

Example Radio



❶ CHANNEL SELECTOR/SW [CH] (p. 14)
Turn to select CH1 to CH16.

❷ VOLUME CONTROL [OFF/VOL]
Turns power ON and adjusts the audio level.

❸ MONITOR (Audi) key [MONI] (p. 21)
- Push and hold to open the noise/tone squelch.
- Push to turn the noise/tone squelch ON.

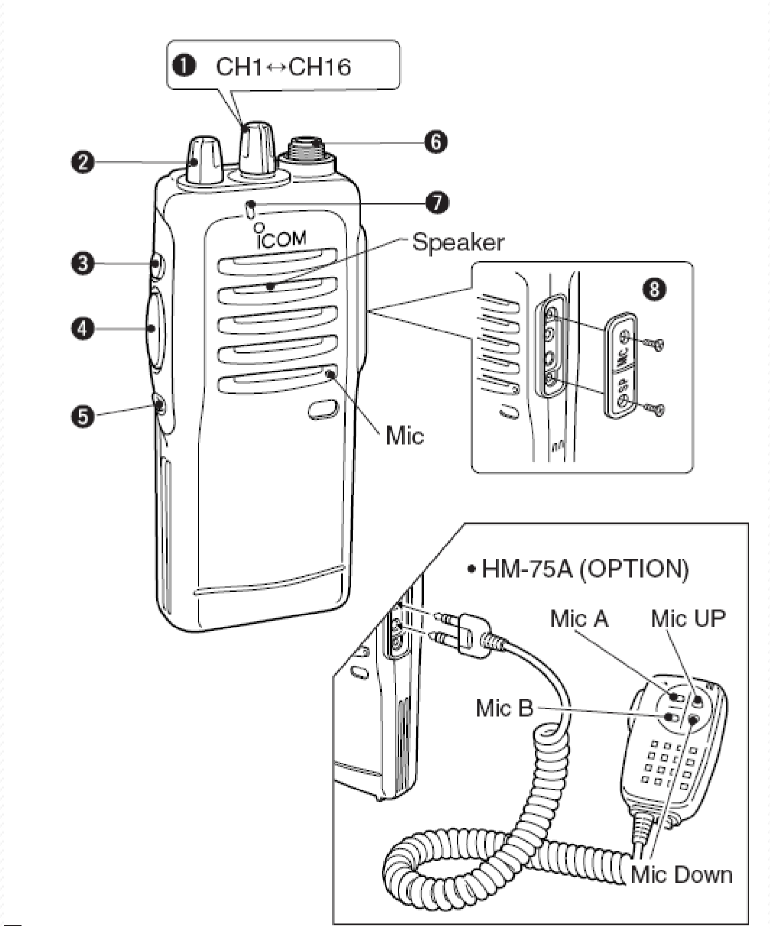
❹ PTT SWITCH [PTT]
Push and hold to transmit; release to receive.

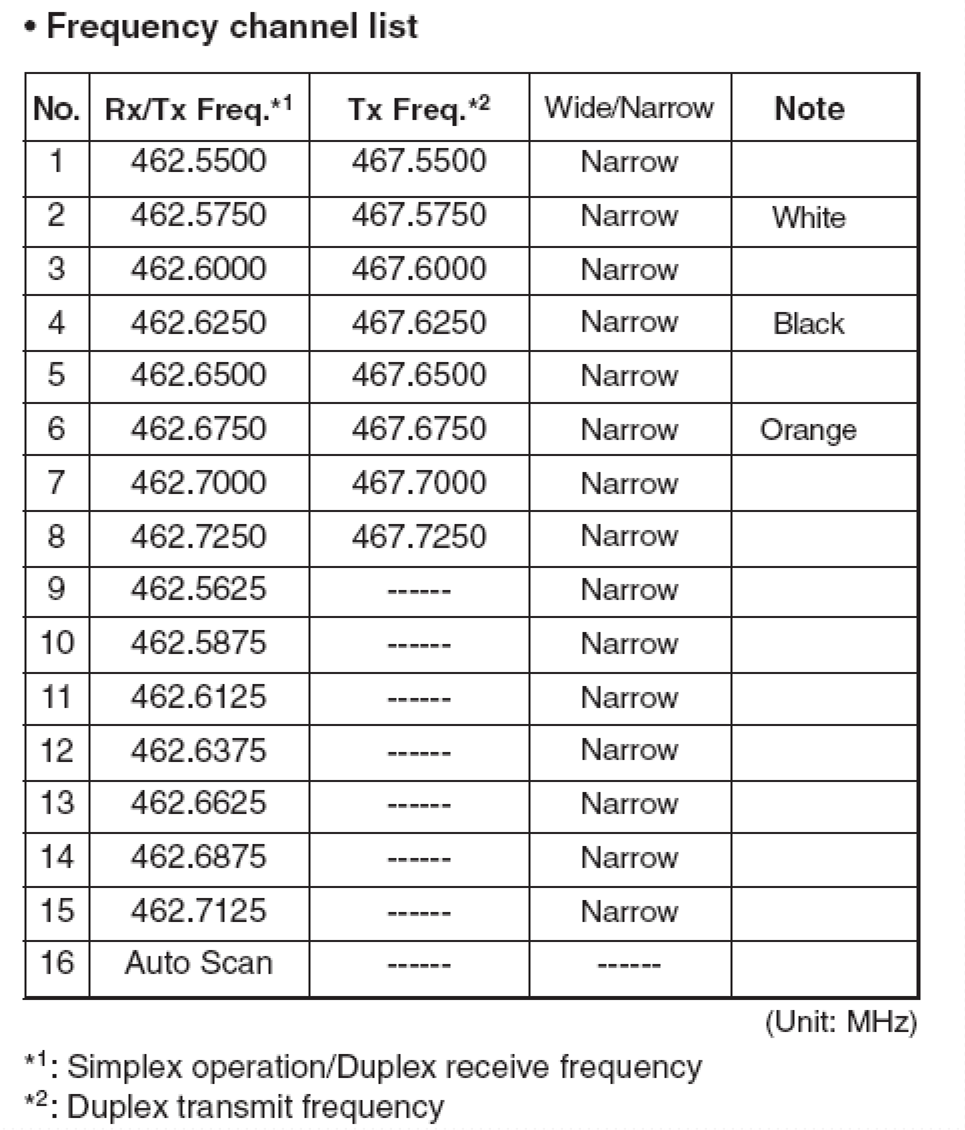
❺ WIDE/NARROW KEY [W/N] (p. 22)
- Push to select Wide FM mode.
- Push and hold to select Narrow FM mode.

❻ ANTENNA CONNECTOR
Connects the supplied antenna.

❼ TX/RX INDICATOR LED (p. 3)
- Lights red while transmitting.
- Lights green while receiving a signal, or squelch is open.

❽ [SP]/[MIC] JACK
Connects optional speaker-microphone.





- **Frequency channel list**

No.	Rx/Tx Freq.*1	Tx Freq.*2	Wide/Narrow	Note
1	462.5500	467.5500	Narrow	
2	462.5750	467.5750	Narrow	White
3	462.6000	467.6000	Narrow	
4	462.6250	467.6250	Narrow	Black
5	462.6500	467.6500	Narrow	
6	462.6750	467.6750	Narrow	Orange
7	462.7000	467.7000	Narrow	
8	462.7250	467.7250	Narrow	
9	462.5625	------	Narrow	
10	462.5875	------	Narrow	
11	462.6125	------	Narrow	
12	462.6375	------	Narrow	
13	462.6625	------	Narrow	
14	462.6875	------	Narrow	
15	462.7125	------	Narrow	
16	Auto Scan	------	------	

(Unit: MHz)

[1]: Simplex operation/Duplex receive frequency

[2]: Duplex transmit frequency

◇ SETTING THE CTCSS TONE FREQUENCY

This transceiver is equipped with 52 CTCSS codes. (See right.) CTCSS operation provides communication with silent standby since you will only receive calls from group members using the same CTCSS number.
You can assign different numbers to CH 1 to CH 15 independently.

① While pushing and holding [PTT], [MONI], [W/N], turn [OFF/VOL] to power ON.
② Select the desired CH 1 to CH 15 that you want to assign the CTCSS tone frequency to.
③ Push and hold [MONI] until a beep (Pi) is emitted.
④ Push [PTT] the necessary number of times to choose the 10 digit of the desired channel from the channel list.
⑤ Push [MONI].
- Confirmation beep is emitted. (See p. 17)

⑥ Push [PTT] the necessary number of times to choose the 1 digit of the desired channel from the frequency list.
⑦ Push [MONI].
⑧ Turn the power OFF, and then ON again.

[Example]

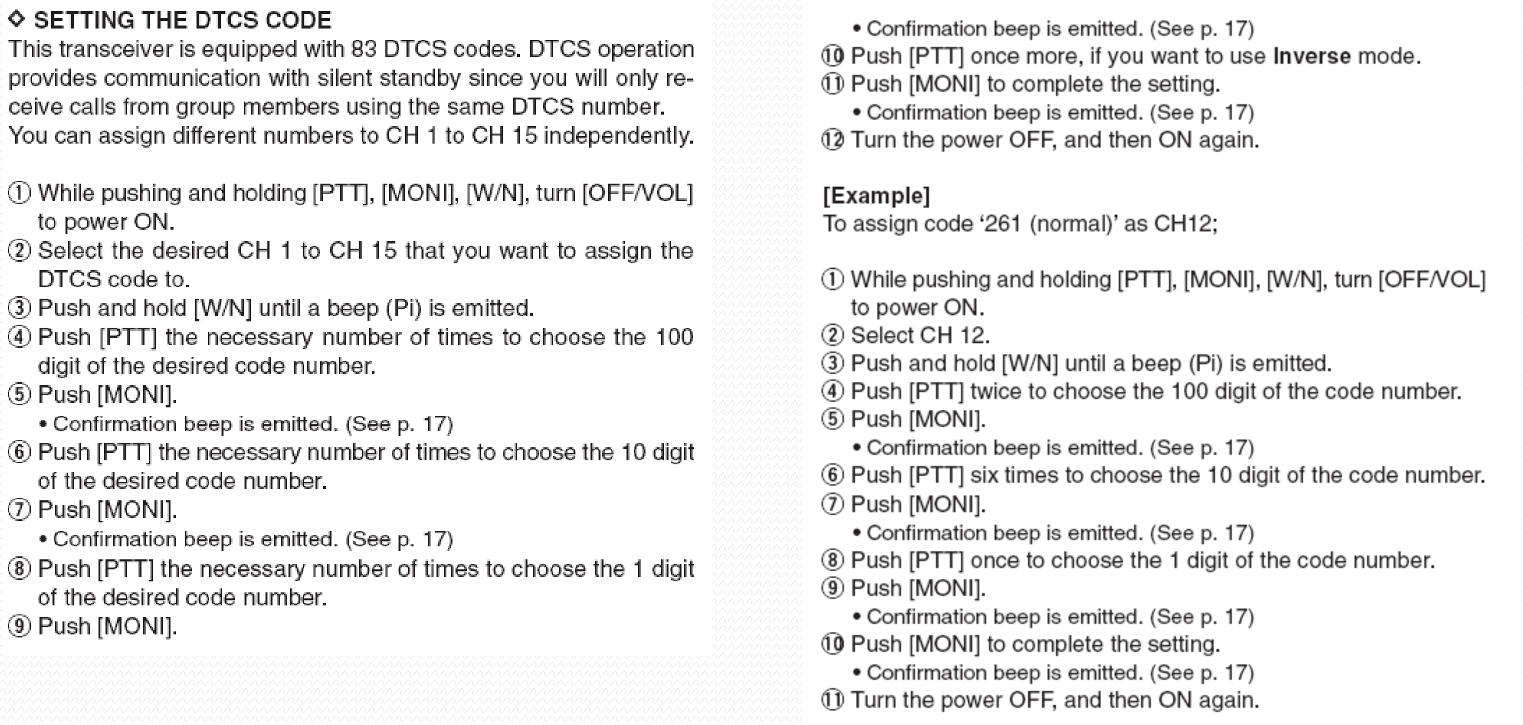
To assign No. 28 as CH1;

① While pushing and holding [PTT], [MONI] and [W/N], turn [OFF/VOL] to power ON.
② Select the CH 1.
③ Push and hold [MONI] until a beep (Pi) is emitted.
④ Push [PTT] twice to choose the 10 digit of the desired channel.
⑤ Push [MONI].
⑥ Push [PTT] eight times to choose the 1 digit of the desired channel.
⑦ Push [MONI].
⑧ Turn the power OFF, and then ON again.

• CTCSS tone code list

No.	Freq.*	No.	Freq.*	No.	Freq.*	No.	Freq.*
0	OFF	16	107.2	32	171.3	48	233.6
1	67.0	17	110.9	33	173.8	49	241.8
2	69.3	18	114.8	34	177.3	50	250.3
3	71.0	19	118.8	35	179.9	51	254.1
4	71.9	20	123.0	36	183.5	52	270.4
5	74.4	21	127.3	37	186.2		
6	77.0	22	131.8	38	189.9		
7	79.7	23	136.5	39	192.8		
8	82.5	24	141.3	40	196.6		
9	85.4	25	146.2	41	199.5		
10	88.5	26	151.4	42	203.5		
11	91.5	27	156.7	43	205.5		
12	94.8	28	159.8	44	210.7		
13	97.4	29	162.2	45	218.1		
14	100.0	30	165.5	46	225.7		
15	103.5	31	167.9	47	229.1		

(Unit: Hz)



◇ **SETTING THE DTCS CODE**

This transceiver is equipped with 83 DTCS codes. DTCS operation provides communication with silent standby since you will only receive calls from group members using the same DTCS number.
You can assign different numbers to CH 1 to CH 15 independently.

① While pushing and holding [PTT], [MONI], [W/N], turn [OFF/VOL] to power ON.
② Select the desired CH 1 to CH 15 that you want to assign the DTCS code to.
③ Push and hold [W/N] until a beep (Pi) is emitted.
④ Push [PTT] the necessary number of times to choose the 100 digit of the desired code number.
⑤ Push [MONI].
- Confirmation beep is emitted. (See p. 17)

⑥ Push [PTT] the necessary number of times to choose the 10 digit of the desired code number.
⑦ Push [MONI].
- Confirmation beep is emitted. (See p. 17)

⑧ Push [PTT] the necessary number of times to choose the 1 digit of the desired code number.
⑨ Push [MONI].
- Confirmation beep is emitted. (See p. 17)

⑩ Push [PTT] once more, if you want to use **Inverse** mode.
⑪ Push [MONI] to complete the setting.
- Confirmation beep is emitted. (See p. 17)

⑫ Turn the power OFF, and then ON again.

[Example]
To assign code '261 (normal)' as CH12;

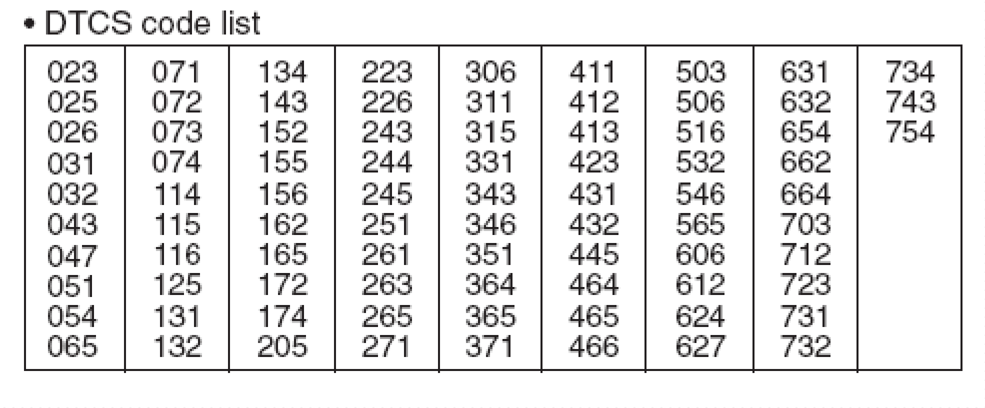
① While pushing and holding [PTT], [MONI], [W/N], turn [OFF/VOL] to power ON.
② Select CH 12.
③ Push and hold [W/N] until a beep (Pi) is emitted.
④ Push [PTT] twice to choose the 100 digit of the code number.
⑤ Push [MONI].
- Confirmation beep is emitted. (See p. 17)

⑥ Push [PTT] six times to choose the 10 digit of the code number.
⑦ Push [MONI].
- Confirmation beep is emitted. (See p. 17)

⑧ Push [PTT] once to choose the 1 digit of the code number.
⑨ Push [MONI].
- Confirmation beep is emitted. (See p. 17)

⑩ Push [MONI] to complete the setting.
- Confirmation beep is emitted. (See p. 17)

⑪ Turn the power OFF, and then ON again.



- DTCS code list

023	071	134	223	306	411	503	631	734
025	072	143	226	311	412	506	632	743
026	073	152	243	315	413	516	654	754
031	074	155	244	331	423	532	662	
032	114	156	245	343	431	546	664	
043	115	162	251	346	432	565	703	
047	116	165	261	351	445	606	712	
051	125	172	263	364	464	612	723	
054	131	174	265	365	465	624	731	
065	132	205	271	371	466	627	732	

GMRS Summary

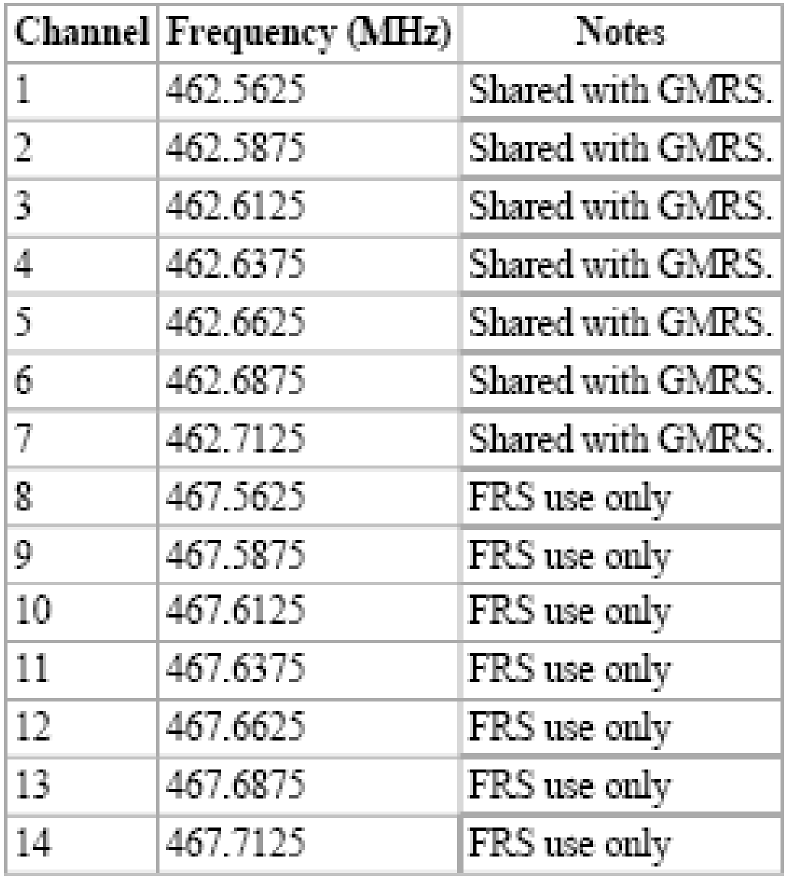
- License
  - $85 for 5 5-year FCC license
- Pros
  - Simple Operation
  - Repeaters
  - Relatively Inexpensive
  - Commercial-grade radios
  - License requires no test
- Cons
  - Limited simplex range in urban areas
  - Interference from other FRS/GMRS users

FRS

- Family Radio Service(FRS) is an unlicensed walkie talkie radio system
- FRS radios are compact, handheld, wireless 2-way FM radios
- FRS radios provide very good clarity over a relatively short range range
- FRS is a license free radio service

FRS Characteristics

- Uses “channelized” frequencies in the ultra high frequency (UHF) band
- Operate on any of 14 dedicated channels
- Is quiet and clear because it uses frequency modulation (FM) instead of amplitude modulation (AM)
- Has limited range (~0.5 mi) because:
  - They have a maximum allowable power of 1/2 watt, and
  - They have a fixed small (poor) antenna



Channel	Frequency (MHz)	Notes
1	462.5625	Shared with GMRS.
2	462.5875	Shared with GMRS.
3	462.6125	Shared with GMRS.
4	462.6375	Shared with GMRS.
5	462.6625	Shared with GMRS.
6	462.6875	Shared with GMRS.
7	462.7125	Shared with GMRS.
8	467.5625	FRS use only
9	467.5875	FRS use only
10	467.6125	FRS use only
11	467.6375	FRS use only
12	467.6625	FRS use only
13	467.6875	FRS use only
14	467.7125	FRS use only

CTCSS & DCS

- Newer radios have 142 privacy codes
  - 38 CTCSS
  - 104 “Digital Coded Squelch” (DCS)
    - Digital data or code word that is transmitted with the voice audio
  - The code words are 23 bit long strings
    - 12 bits of octal code followed by 11 bits of CRC
    - This makes a total of 23 bits sent in a Golay encoded words
    - There are no sync bits and the baud rate is 134.4
    - Each bit is 7.5 msec in length, for a total of 172.5 msec

FRS Special Requirements

- Integral Antenna is required
  - No modification allowed!!
- FRS radios can transmit GPS Data
  - Allowed Transmissions:
    - Send a radio location
    - Request a radio location
    - Send a text message

Regulations

- You are provided authority to operate a FRS unit in places where the FCC regulates radio communications as long as you use only an unmodified FCC certified FRS unit
  - An FCC certified FRS unit has an identifying label placed on it by the manufacturer
- You can operate on an aircraft or ship with the captain’s permission within or over any area of the world where radio services are regulated by the FCC or upon or over international waters
- There is no age or citizenship requirement

What can I do with this service?

- FRS is used by family, friends and associates to communicate within a neighborhood and while on group outings and has a communications range of less than one mile
- You may use your FRS unit for business-related communications
- You may use an FRS unit to conduct two-way voice communications with another person
- You may use an FRS unit to transmit:
  - one-way voice or non-voice communications only to establish communications with another person
  - send an emergency message
  - provide traveler assistance
  - provide location information
  - transmit a brief text message
  - make a voice page
  - or to conduct a brief test

Special Use & Canada

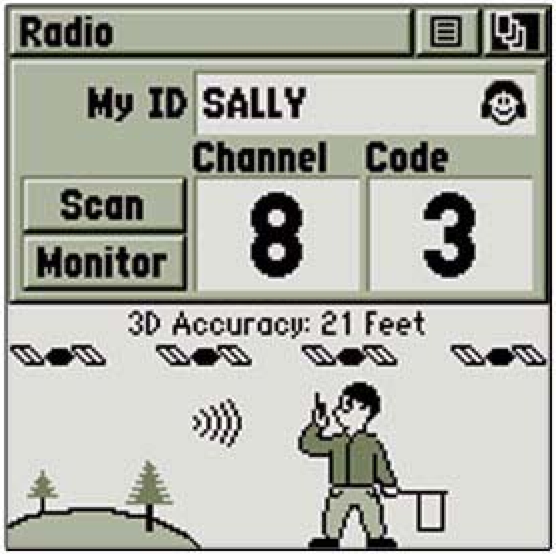
- Some clubs have recommended FRS Channel 1 as a national emergency/calling channel
  - REACT International, Inc. and the National SOS Radio Network
- Channel 2 is typically used by geocaching groups when trying to connect with other geocachers
- Canada:
  - American-standard FRS radios have been approved for use in Canada since April 2000
  - The revised technical standard RSS 210 has essentially the same technical requirements as in the United States

Digital Data

- FRS unit may transmit digital data containing:
  - location information, or
  - requesting location information from one or more other FRS units,
  - or containing a brief text message to another specific FRS unit
- Digital data transmissions shall not exceed one second
- Shall be limited to no more than one digital transmission within a thirty-second period
  - Except that an FRS unit may automatically respond to more than one interrogation request received within a thirty-second period

FRS with GPS

- Transmit your GPS position to other users

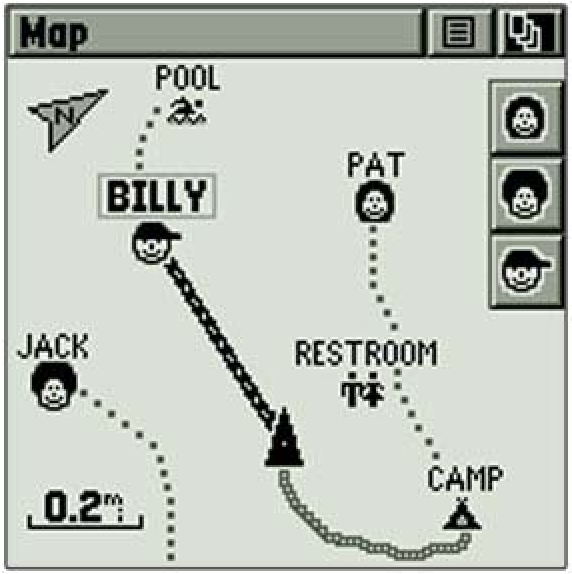


My ID SALLY

Channel 8

Code 3

3D Accuracy: 21 Feet



Puerto Rico

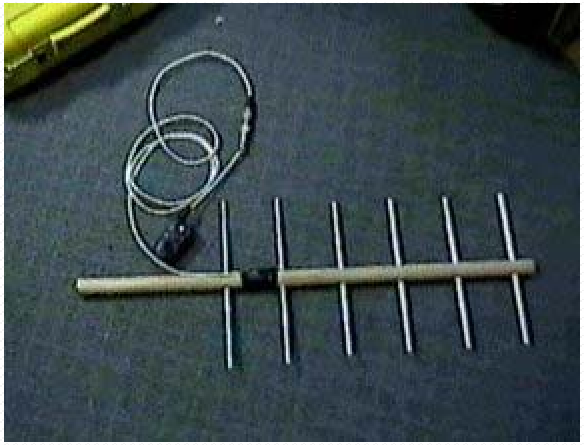
- Anyone intending to operate an FRS unit on the islands of Puerto Rico, Desecheo, Mona, Vieques, and Culebra in a manner that could pose an interference threat to the Arecibo Observatory shall notify (45 days prior to commencing operation of the unit):
    - Interference Office, Arecibo Observatory, HC3 Box 53995, Arecibo, Puerto Rico 00612

FRS Operating Procedures

- You are responsible for all communications that you make with the FRS unit
- You must share each channel with other users
- No channel is available for the private or exclusive use of any user
- You can not make a telephone call with an FRS unit
- You must not use an FRS unit in connection with any activity which is against federal, state or local law
- You must, at all times and on all channels, give priority to emergency communication messages concerning the immediate safety of life or the immediate protection of property

Prohibited

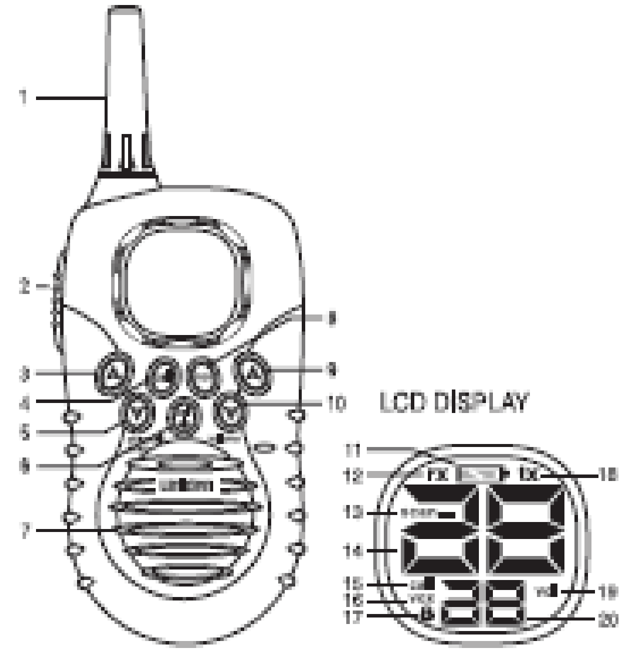
- You must not make, or have made, any internal modification to an FRS unit
  - Any internal modification cancels the FCC certification and voids your authority to operate the unit in the FRS
- You may not attach any antenna, power amplifier, or other apparatus to an FRS unit that has not been FCC certified as part of that FRS unit
- There are no exceptions to this rule and attaching any such apparatus to a FRS unit cancels the FCC certification and voids everyone's authority to operate the unit in the FRS
- FRS units are prohibited from transmitting data in store-and-forward packet operation mode



Example Radio

- Volume and on/off
- Channel Select
- Push to Talk
- Monitor (opens squelch)
- Select (menus)
- Call
    - Sends a “ring tone” to other nearby FRS radios

GMRS680 RADIO



1	Antenna	11	Battery Level Meter
2	PTT (Push-To-Talk) Button	12	Receive Indicator
3	Channel/Scan Up Key	13	Scan Indicator
4	Call Key	14	Channel Indicator
5	Channel/Scan Down Key	15	Call Indicator
6	Sel/ ⏻ Key	16	VOX Indicator
7	Speaker	17	Keypad Lock Indicator
8	Mon Key	18	Transmit Indicator
9	Volume Up Key	19	Volume Setting Indicator
10	Volume Down Key	20	CTCSS Indicator

FRS Features

- Backlight —for nighttime or low-light use
- Adjustable squelch —filter out static and interference
- VOX system — voice activation system automatically puts radio in transmit mode when the radio detects noise, facilitating hands-free operation when used with an optional headset. Not recommended for emergency communication use!
- Ringer — an audible tone indicating an incoming call from a member of your party
- Silent vibrating ringer — causes the radio to vibrate rather than ring, to indicate an incoming call
- Auto scan — automatically scans all available channels for signals
- Selectable power level — allows you to choose high power for longer range or low power to extend battery life on shorter range transmissions
- Out-of-range alert — Indicates when someone in your party has moved out of range
- Keypad lock —prevents changing settings, such as channel selected, should you inadvertently bump the keypad
- Battery indicator — Provides an indication of how much transmitting power is left and when batteries need replacement
- Battery type — FRS and GMRS radios may use AA or AAA batteries. Many models also use NiMH rechargeable batteries and may include a battery pack and charger
- NOAA Weather Radio

From http://www.bestbuy.com

FRS Equipment & Accessories

- FRS Radios
  - Wide range <$30 to >$150
- Batteries
- Chargers
- Speaker Mics
- Earpieces
- Belt Clips
- Cases

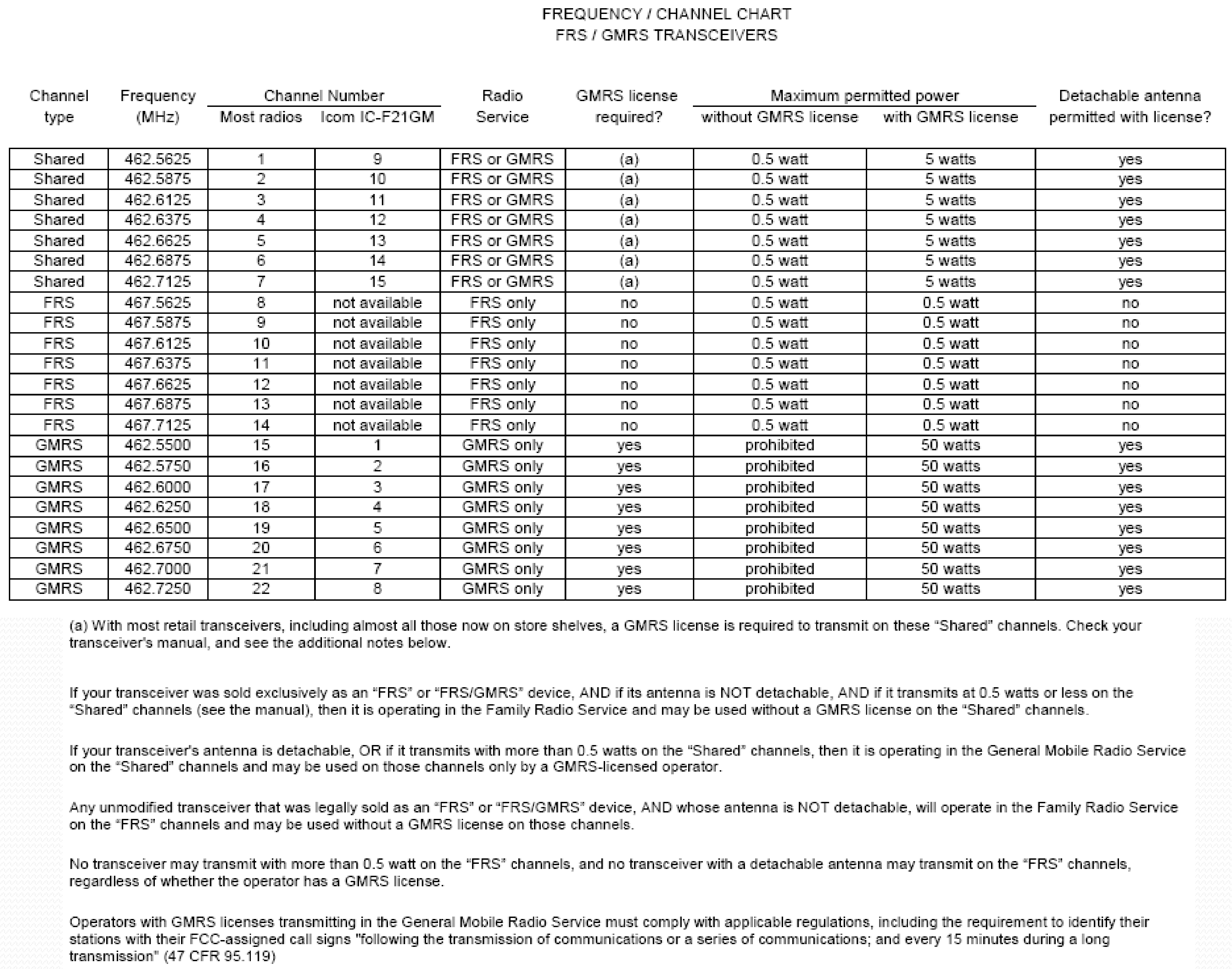
MODEL: FA-AA
HIGH CAPACITY
NICKEL METAL HYDRIDE
BATTERY PACK
3.6V 1200mAh
Nickel Metal Hydride battery must be recycled or disposed of properly
MADE IN TAIWAN
CAUTION!
DO NOT INSERT INTO RADIO WITH THIS SIDE FACING OUT

FRS Summary

- License
  - None
- Pros
  - Simple Operation
  - Very Inexpensive
  - Readily available
  - No license required
  - Shares frequencies with GMRS
- Cons
  - Poor range in urban areas
  - No repeaters
  - Interference from other FRS/GMRS users
  - Not usually rugged or waterproof

Combo FRS/GMRS Radios

- These common radios provide access to both the FRS and GMRS bands
  - FRS channels (1 1-14) and
  - GMRS channels (1-7 & 15-22)
- GMRS channels 15-22 requires an FCC GMRS license
- These radios may be used without a license, if ……
  - the “FRS only” channels (8-14) are used, or
  - channels 1-7 are used on low power (<0.5 w)
- Must have integral antenna
- Most “blister pack” Radios sold today are dual purpose (FRS/GMRS)



FREQUENCY / CHANNEL CHART
FRS / GMRS TRANSCEIVERS

Channel type	Frequency (MHz)	Channel Number		Radio Service	GMRS license required?	Maximum permitted power		Detachable antenna permitted with license?
		Most radios	Icom IC-F21GM			without GMRS license	with GMRS license	
Shared	462.5625	1	9	FRS or GMRS	(a)	0.5 watt	5 watts	yes
Shared	462.5875	2	10	FRS or GMRS	(a)	0.5 watt	5 watts	yes
Shared	462.6125	3	11	FRS or GMRS	(a)	0.5 watt	5 watts	yes
Shared	462.6375	4	12	FRS or GMRS	(a)	0.5 watt	5 watts	yes
Shared	462.6625	5	13	FRS or GMRS	(a)	0.5 watt	5 watts	yes
Shared	462.6875	6	14	FRS or GMRS	(a)	0.5 watt	5 watts	yes
Shared	462.7125	7	15	FRS or GMRS	(a)	0.5 watt	5 watts	yes
FRS	467.5625	8	not available	FRS only	no	0.5 watt	0.5 watt	no
FRS	467.5875	9	not available	FRS only	no	0.5 watt	0.5 watt	no
FRS	467.6125	10	not available	FRS only	no	0.5 watt	0.5 watt	no
FRS	467.6375	11	not available	FRS only	no	0.5 watt	0.5 watt	no
FRS	467.6625	12	not available	FRS only	no	0.5 watt	0.5 watt	no
FRS	467.6875	13	not available	FRS only	no	0.5 watt	0.5 watt	no
FRS	467.7125	14	not available	FRS only	no	0.5 watt	0.5 watt	no
GMRS	462.5500	15	1	GMRS only	yes	prohibited	50 watts	yes
GMRS	462.5750	16	2	GMRS only	yes	prohibited	50 watts	yes
GMRS	462.6000	17	3	GMRS only	yes	prohibited	50 watts	yes
GMRS	462.6250	18	4	GMRS only	yes	prohibited	50 watts	yes
GMRS	462.6500	19	5	GMRS only	yes	prohibited	50 watts	yes
GMRS	462.6750	20	6	GMRS only	yes	prohibited	50 watts	yes
GMRS	462.7000	21	7	GMRS only	yes	prohibited	50 watts	yes
GMRS	462.7250	22	8	GMRS only	yes	prohibited	50 watts	yes

(a) With most retail transceivers, including almost all those now on store shelves, a GMRS license is required to transmit on these “Shared” channels. Check your transceiver's manual, and see the additional notes below.

If your transceiver was sold exclusively as an “FRS” or “FRS/GMRS” device, AND if its antenna is NOT detachable, AND if it transmits at 0.5 watts or less on the “Shared” channels (see the manual), then it is operating in the Family Radio Service and may be used without a GMRS license on the “Shared” channels.

If your transceiver's antenna is detachable, OR if it transmits with more than 0.5 watts on the “Shared” channels, then it is operating in the General Mobile Radio Service on the “Shared” channels and may be used on those channels only by a GMRS-licensed operator.

Any unmodified transceiver that was legally sold as an “FRS” or “FRS/GMRS” device, AND whose antenna is NOT detachable, will operate in the Family Radio Service on the “FRS” channels and may be used without a GMRS license on those channels.

No transceiver may transmit with more than 0.5 watt on the “FRS” channels, and no transceiver with a detachable antenna may transmit on the “FRS” channels, regardless of whether the operator has a GMRS license.

Operators with GMRS licenses transmitting in the General Mobile Radio Service must comply with applicable regulations, including the requirement to identify their stations with their FCC-assigned call signs "following the transmission of communications or a series of communications; and every 15 minutes during a long transmission" (47 CFR 95.119)

Marketing Claims

- This radio will transmit with the "full legal power" up to 5 miles, 2 miles, 3 miles, 7 miles, 12 miles, even 25 miles!
- Really???
- But how far can I *really* talk??
  - The output power of the radio
  - The height of the transmitting and receiving antenna
  - The position of the antenna relative to the Earth
  - The terrain and vegetation

MURS

- Private, two way, short distance voice, data or image communications service for personal or business use
- Permitted Frequencies:
  - 151.82, 151.88, 151.94, 154.57, & 154.6 MHz
- Maximum Power for MURS equipment is 2 watts
- Range – a couple of miles, maybe up to 10 miles with external antenna (terrain factors in)
- Each of the five MURS channels has 38 CTCSS tones you can choose from
- Combination MURS/FRS devices are prohibited
- Highest point of any MURS antenna must no be more than 18.3 meters (60 feet) above the ground or 6.10 meters (20 feet) above the highest point of the structure on which it is mounted
  - An advantage of MURS is that you may connect an external antenna to your radio
- MURS operation is authorized anywhere CB station operation is permitted
  - Allowed aboard any vessel of the United States, with the permission of the captain, while the vessel is travelling either domestically or in international waters
  - MURS operation is not authorized aboard aircraft in flight

What can I transmit on MURS?

- MURS stations may transmit voice or data signals
- MURS frequencies may be used for remote control and telemetering functions
- MURDS users shall take reasonable precautions to avoid causing harmful interference
  - This includes monitoring the transmitting frequency for communications in progress and such other measures as may be necessary to minimize the potential for causing interference
- Channels authorized to MURS systems by this part are available on a shared basis only and will not be assigned for the exclusive use of any entity
- MURS stations are prohibited from operating as a repeater station or as a signal booster
  - This prohibition includes store-and-forward packet operation
- MURS stations are prohibited from interconnection with the public switched network

Data Transmissions

- Maximum authorized bandwidth is 11.25 KHz on the three 151 MHz frequencies (151.820 MHz, 151.880 MHz and 151.940 MHz)
- Maximum authorized bandwidth is 20.0 KHz on the two 154 MHz frequencies (154.570 MHz and 154.600 MHz)
- Radio must be certified for MURS
- Radio is certified for data communications
  - Or transmissions otherwise comply with the rules and those transmissions can be imposed on a conventional voice emission
- You may not make any internal modifications or additions to a MURS radio to transmit data communications

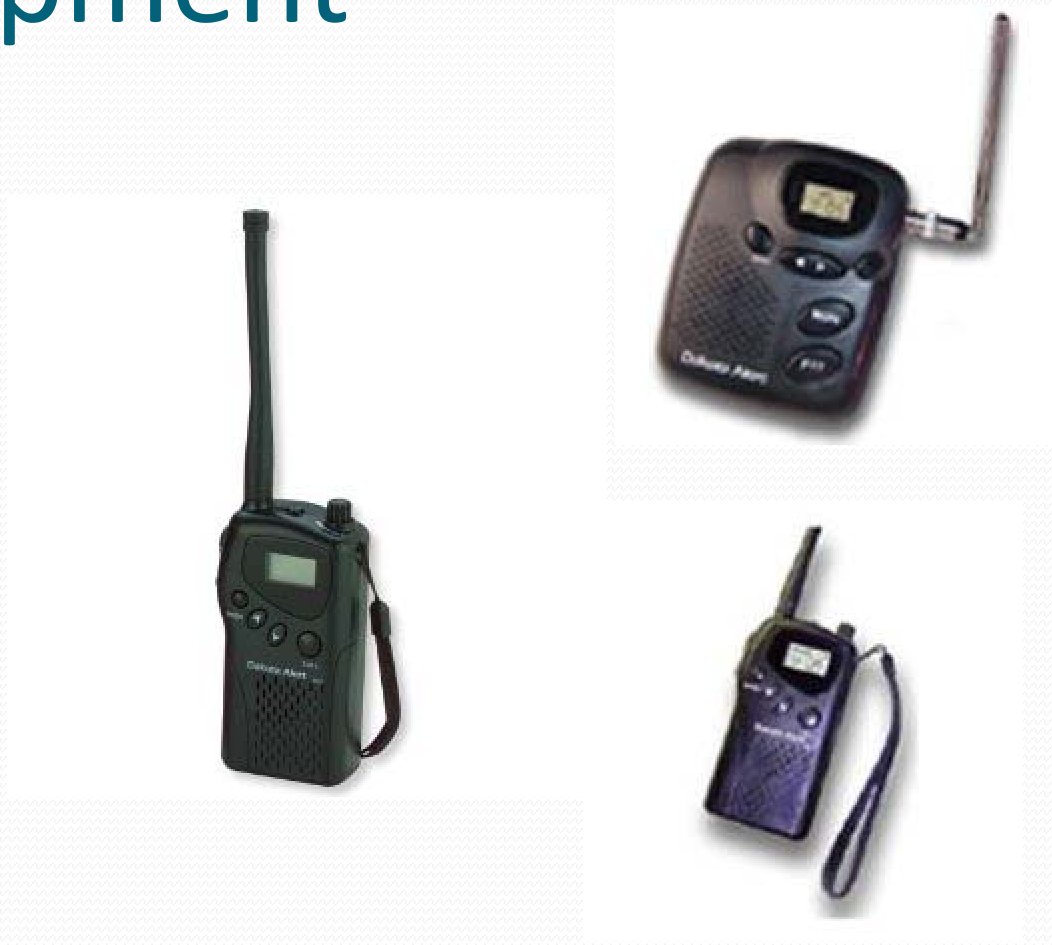
Markets:

Gas and oil flow monitoring
Industrial telemetry
Irrigation control
Wireless remote control
Wireless SCADA systems
Public Safety AVL
Vehicle tracking and asset tracking systems
Off-road Racing and Chase Trucks
Electric, Water, and gas utilities
Water monitoring
Wastewater management

Raveon Technologies, www.raveon.com

MURS Equipment

- Base Station
- Handhelds
- Low cost
  - ~$25 - $150



Just a note on Amateur Radio

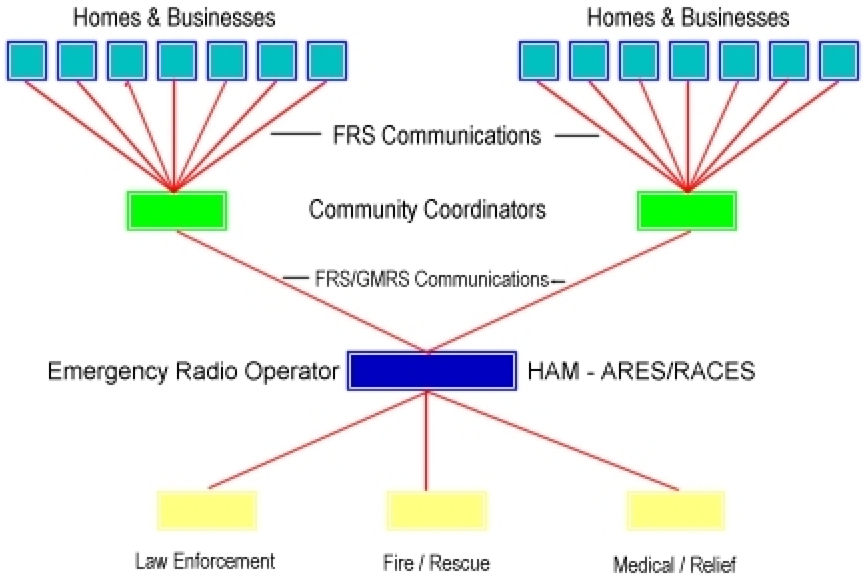
- Part 97 FCC Rules
- License Required
  - With an exam
- Technician, General and Extra class
- A lot of frequencies
- A lot of fun!!
- www.arrl.org

READY • RESILIENT • RESPONSIVE
AMATEUR RADIO
1935 2010
EMERGENCY SERVICE
Seventy Five Years

Amateur Radio

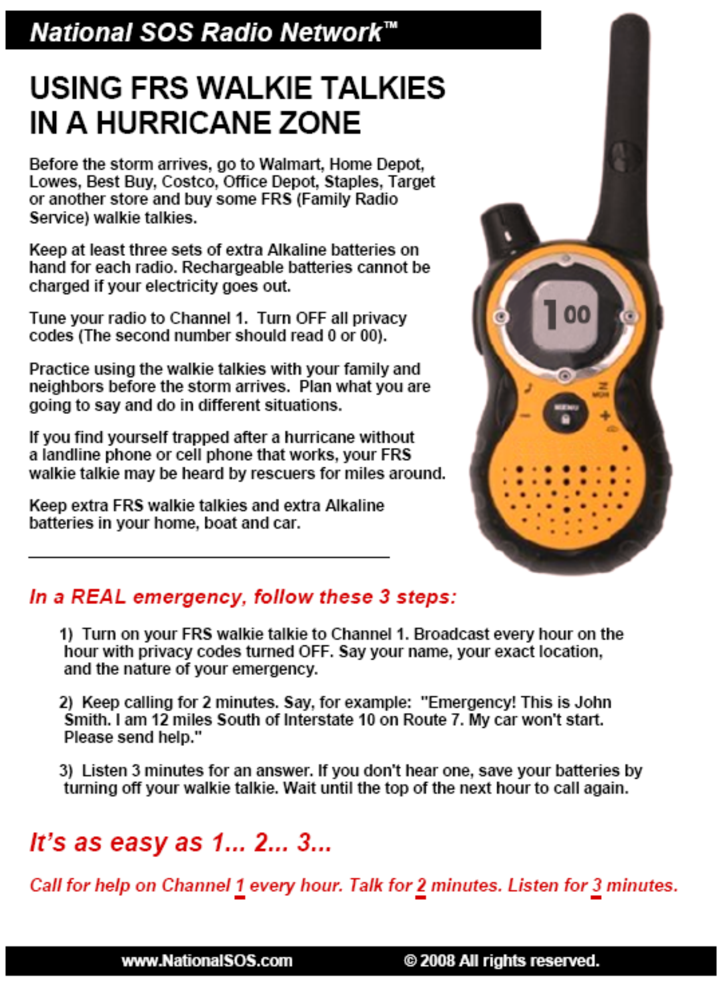
- Amateur (Part 97) and Part 95 combo transceivers are not permitted
  - one exception is that Part 97 (Amateur)/Part 87 (Aviation VHF 118-136.975 MHz) combo transceivers are permitted but must be approved by the FAA Spectrum Engineering Division
  - market this radio only to the aviation community including licensed pilots, aircraft owners, other aeronautical Radio licensees, and other legitimate members of the aviation industry

Putting Together a Neighborhood Communications Network



Emergency Back-Up Communications
Sample Method

EMCOM Project - Nationwide Network of Neighborhood based Community Emergency Preparedness Coordinators



National SOS Radio Network™

USING FRS WALKIE TALKIES IN A HURRICANE ZONE

Before the storm arrives, go to Walmart, Home Depot, Lowes, Best Buy, Costco, Office Depot, Staples, Target or another store and buy some FRS (Family Radio Service) walkie talkies.

Keep at least three sets of extra Alkaline batteries on hand for each radio. Rechargeable batteries cannot be charged if your electricity goes out.

Tune your radio to Channel 1. Turn OFF all privacy codes (The second number should read 0 or 00).

Practice using the walkie talkies with your family and neighbors before the storm arrives. Plan what you are going to say and do in different situations.

If you find yourself trapped after a hurricane without a landline phone or cell phone that works, your FRS walkie talkie may be heard by rescuers for miles around.

Keep extra FRS walkie talkies and extra Alkaline batteries in your home, boat and car.

In a REAL emergency, follow these 3 steps:

1) Turn on your FRS walkie talkie to Channel 1. Broadcast every hour on the hour with privacy codes turned OFF. Say your name, your exact location, and the nature of your emergency.
2) Keep calling for 2 minutes. Say, for example: "Emergency! This is John Smith. I am 12 miles South of Interstate 10 on Route 7. My car won't start. Please send help."
3) Listen 3 minutes for an answer. If you don't hear one, save your batteries by turning off your walkie talkie. Wait until the top of the next hour to call again.

It's as easy as 1... 2... 3...

Call for help on Channel 1 every hour. Talk for 2 minutes. Listen for 3 minutes.

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